Attachment 3

Calculations

Estimate of dose rates from ARA-16 piping at JCO limits.

Reference: 1. Radiological Health Handbook, Public Health Service, January 1970.

2. Mark's Handbook, 7th edition

1. Assume radionuclide mixture same as for ARA-16 sludge

2. Use RADCALL data from Attachment 2

Cs-137 activity = 2.51×10^{-1} Ci

Total activity (activity (delayed to April 2000) = 5.2×10^{-1} Ci

$$fraction\ \ Cs-137\ activity = \frac{2.51 \times 10^{-1}}{5.2 \times 10^{-1}} = 0.4827$$

Assume 1 ft of 4 inch sch 40 pipe

from Ref. (2) page 8-201, inside surface area 4" pipe = 1.054 ft^2/ft

(1.054 ft^2)(925 cm^2/ft^2) = 979 cm^2/ft

SCD-II allows 8×10^5 sq/cm^2 of contamination

(8×10^5 ?g/cm^2) (979 cm^2/ft pipe) = 7.83×10 ?g/ft pipe

(7.83×10^8 ?g/ft pipe)/(3.7×10^{10} ?g/Ci) = 0.0212 Ci/ft pipe

From page 205 of Ref. (1):

Dose rate = 6 C ?

C = Curies

E = gamma energy in MeV

Dose rate = dose rate in R/Hr at 1 ft from a point source

Dose rate from 1 ft pipe = 6 C ?

C = curries of Cs-137 = (.0212 (:) (.4827) = 0.0102 Ci

E of Cs-137 = .661 MeV

Dose rate from 1 ft pipe = (6) (.0102) (.661) = 0.040 R/H.

Dose rate from 1 ft. pipe = 40 mR/H.

Calculated by: Gene K. Kanemoto 4/22/2000

Estimate of dose rates from ARA-02 materials at LSA/SCO limits

Reference: Radiological Health Handbook, Public Health Service, January 1970.

1. Assume radionuclide mixture from pages A-7 and A-8 of the Field Sampling Plan for the seepage pit sludge.

2. Use RADCALC results for the seepage pit sludge in Attachment 2.

A_2 value = 0.0452 Ci

Co-60 activity = 8.74×10^{-11} Ci/gm

Cs-137 activity = 1.78×10^{-10} Ci/gm } Evaluate for Co and Cs since they appear to be the dominate gamma emitters

Total activity = 2.17×10^{-9} Ci/gm

$$Co-60 \textit{ fraction of total activity} = \frac{8.74 \times 10^{-11}}{2.17 \times 10^{-9}} = .04027$$

$$Cs-137 \textit{ fraction of total activity} = \frac{1.78 \times 10^{-10}}{2.17 \times 10^{-9}} = .08202$$

LSA-II allows $10^{-4}A_2$/gm

For ARA-02 LSA-II limit = $.0453 \times 10^{-4}$ Ci/gm

For 10 kg = $(.0453 \times 10^{-4}$ Ci/gm) $(10 \times 10^{3}$gm) = .0453 Ci

Co-60 = (.0453 Ci) (.04027) = .00182 Ci

Cs-137 = (.0453 Ci) (.08202) = .00371 Ci

From page 205 of the reference:

Dose rate = 6 C E

Dose rate = dose rate in R/Hr @ 1 ft from point source

C = Curies

E = gamma energy in MeV

E for Co-Co = 2.4 MeV

E for Cs-137 = .661 Mev

Dose from Co-60 = C (.00182) (2.4) = .026 R/Hr = 26 mR/Hr

Dose from Cs-137 = C (.00371) (.661) = .015 R/Hr = 15 mR/Hr

Total dose from Cs-60 and Cs-137 = (25 + 15) = 41 mR/Hr from 10 kg of material

or SCO-II – allows up to 8×10^5 ?g/cm^2

Total activity for 1 m^2 = (8×10^5 ?g/cm^2) (100 cm) (100 cm)

= 8×10^2 ?g/m^2

(8×10^5 ?g)/(3.7×10^{10} ?g/Ci) = 0.216 Ci/m^2

Dose from Co-60 = (6) (.216)(2.4)(.04027) = .125 R/Hr = 125 mR/H.

Dose from Cs-137 = (6)(.216)(.661)(.08202) = .070 R/Hr = 70 mR/H.

Total dose from Co-60 and Cs-137 = (125 + 70) = 195 mR/Hr from 1 sg meter

Calculated by: Gene K. Kanemoto 4/30/2000